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Ground State Cooling of the Radial and Axial Modes of a Single Ion in a Penning Trap

Following results of laser cooling a single ion of $^{40}\text{Ca}^+$ to its motional ground state ($\bar{n}_z = 0.02(1)$) in the axial domain of a Penning trap [1], we report simultaneous sideband cooling of both radial modes to near their ground state in the same apparatus. Sideband cooling is performed on the $S_{1/2} \leftrightarrow D_{5/2}$ electric quadrupole transition at 729 nm, and average phonon numbers for the magnetron and modified cyclotron modes are found to be $\bar{n}_- = 0.7(2)$ and $\bar{n}_+ = 0.3(1)$ respectively. The observation of Rabi oscillations in both the axial and radial domains shows that the electronic state of the ion can be coherently manipulated.

Summary

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